CLAIMS

What is claimed is:

1. A method for determining a flow parameter of a fluid stream within a conduit that extends into a well bore, comprising:

deploying an optical fiber to measure a temperature at a location along the conduit, the temperature being representative of the fluid temperature at the location; and

deriving a flow rate for the fluid based on the temperature at the location.

2. The method as recited in claim 1, wherein the flow rate is a mass flow rate.

3. The method as recited in claim 1, wherein deploying comprises measuring a temperature profile along at least part of the conduit and deriving comprises deriving a flow rate for the fluid based on the temperature profile.

4. The method as recited in claim 3, wherein deriving comprises deriving the flow rate for the fluid based on the temperature profile relative to a natural geothermal profile.

5. The method as recited in claim 3, further comprising measuring the temperature profile at a plurality of times and deriving the flow rate for the fluid based on the temperature profile measured at the plurality of times.

6. The method as recited in claim 5, wherein deriving comprises calculating at least one constant from the temperature profile measured at the plurality of times.

7. The method as recited in claim 1, wherein deploying comprises establishing a distributed temperature measuring apparatus.

8. The method as recited in claim 1, wherein deploying comprises deploying the optical fiber in the fluid.

9. The method as recited in claim 1, wherein deploying comprises deploying the optical fiber along an exterior of the conduit.

10. The method as recited in claim 1, wherein deploying comprises passing light along the optical fiber and receiving light reflected from the optical fiber, the reflected light being indicative of the fluid temperature.

11. The method as recited in claim 1, further comprising installing the optical fiber in a thermally conductive tube.

12. The method as recited in claim 11, further comprising forming the thermally conductive tube in a U-shape extending along the conduit.

13. The method as recited in claim 3, further comprising determining the presence of a change in the cross-sectional area of the conduit by analyzing the temperature profile.

14. A system for determining a mass flow rate of a fluid, comprising:

a conduit extending through a surrounding heat sink;

an optical distributed temperature sensing device disposed along the conduit; and

an instrumentation device coupled to the distributed temperature sensing device to determine a temperature profile of the fluid for derivation of the mass flow rate of the fluid.

15. The system as recited in claim 14, wherein the conduit comprises production tubing for the production of oil.

16. The system as recited in claim 14, wherein the conduit comprises a casing lining a well bore.

17. The system as recited in claim 14, wherein the distributed temperature sensing device comprises an optical fiber.

18. The system as recited in claim 17, wherein the optical fiber extends from the instrumentation device in a generally U-shaped loop.

19. The system as recited in claim 14, wherein the instrumentation comprises a laser.

20. The system as recited in claim 14, wherein the distributed temperature sensing device is configured to sense temperature at a plurality of locations along the conduit.

21. A method for determining a parameter related to fluid flow, comprising:

providing a fluid flow path through a heat sink;

determining a natural thermal profile along the heat sink;

measuring temperature at a plurality of locations along the fluid flow path with a distributed temperature sensing system; and

deriving a mass flow rate of a fluid flowing along the fluid flow path based on the natural thermal profile of the heat sink and the temperature measurements at the plurality of locations.

22. The method as recited in claim 21, wherein providing comprises locating a conduit in an underground formation.

23. The method as recited in claim 21, wherein providing comprises locating a conduit in a well bore.

24. The method as recited in claim 23, wherein measuring comprises deploying an optical fiber along the conduit to sense temperature at a plurality of locations along the conduit.

25. The method as recited in claim 24, wherein deploying comprises placing the optical fiber in a thermally conductive tube.

26. The method as recited in claim 21, wherein measuring comprises sensing a temperature profile along a length of the fluid flow path.

27. The method as recited in claim 21, wherein measuring comprises sensing the temperature at a plurality of times and wherein deriving comprises deriving the mass flow rate based on the temperature measures at the plurality of times.

28. A method for determining a parameter related to fluid flow in an underground formation, comprising:

obtaining distributed temperature profiles with an optical fiber deployed along a fluid flow path through the underground formation; and

using the distributed temperature profiles to determine mass flow rates of fluid flowing along the fluid flow path.

29. The method as recited in claim 28, further comprising measuring a natural thermal profile along the underground formation.

30. The method as recited in claim 28, further comprising monitoring the mass flow rates of fluid along the fluid flow path.

31. The method as recited in claim 28, further comprising calibrating temperature measurement via the optical fiber.

32. The method as recited in claim 28, further comprising utilizing a conduit to form the fluid flow path.

33. The method as recited in claim 32, further comprising producing oil through the conduit.

34. The method as recited in claim 32, further comprising producing gas through the conduit.

35. The method as recited in claim 32, further comprising producing water through the conduit.

36. The method as recited in claim 28, wherein using comprises

calculating at least one constant from the distributed temperature profiles.